

SRB CRITICAL ITEMS LIST

SUBSYSTEM: STRUCTURES AND MISCELLANEOUS ITEMS

ITEM NAME: Thermal Protection System - SRB/ET Attach Ring/Attach Struts Closeout

PART NO.: 10755-0049 thru -0058, FM CODE: A01
10755-0060, 10100-0061

ITEM CODE: 60-03-10A REVISION: Basic

CRITICALITY CATEGORY: 1 REACTION TIME: Seconds

NO. REQUIRED: 1 Per Strut DATE: March 1, 2001

CRITICAL PHASES: Boost SUPERCEDES: March 31, 1998

FMEA PAGE NO.: E-42 ANALYST: S. Parvathaneni

SHEET 1 OF 5 APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: Loss of Strut Closeout Covers thermal protection caused by:

- O Degraded thermal or physical properties due to improper constituents, formulation, mix, application, cure or natural environments. (Degraded Properties)
- O Inadequate TPS thickness. (Inadequate Thickness)
- O Debonding due to improper application of substrate protective finish, improper substrate preparation and vulcanization. (Debonding)

FAILURE EFFECT SUMMARY: Loss of mission, vehicle and crew due to loss of flight control and/or separation capability.

RATIONALE FOR RETENTION:

A. DESIGN

The Attach Ring/Strut Closeout Covers are insulated with 0.50 inch thick EPDM rubber vulcanized to the substrates. The EPDM rubber bears against the strut but does not form a seal. The Attach Ring/Strut cavities are filled with PR-855 silicone foam and a 0.25 inch thick layer of 3-6077 RTV rubber is located between the foam and closeout covers to restrict the flow of hot gases. The strut cables are spiral wrapped with two layers of SNS 300AR tape to further preclude damage from overheating. The insulated covers are installed with mechanical fasteners which are closed out with K5NA/RT 455 (ALT.) at specified locations.

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Thermal protection requirements are presented in SE-019-068-2H, (SRB Thermal Design Data Book). Thermal insulation requirements were established by test and analysis.

Material properties were determined by development testing. The range of thermal environments, acoustic and vibration, stress and pressure loads were obtained from applicable documentation and encompassed the maximum and minimum values. Design properties derived from these tests are reported in SE-019-068-2H.

Verification testing was performed per "SRB/TPS Verification Test Plan," NASA Letters EP44(79-54) and EE11(S-80-34), using analytically determined TPS material thicknesses, maximum heat loads and rates for the applicable regions, and representative model configurations. Subsequent changes in TPS materials, thickness, configuration, etc. were verified on an individual basis using current environments and loads. Subsequent changes in SRB environments were reviewed to verify that original verification parameters were not exceeded.

Certification was performed per document SE-019-149-2H, (SRB/TPS Certification Plan). Subsequent changes in TPS materials and/or thickness or configuration will be certified based on verification test results. Changes to certification requirements (environments and/or loads) are reviewed to verify that existing requirements are not exceeded.

The following Certificates of Qualification (COQs) are applicable to the TPS materials required:

PR-855	-	USA SRBE COQ A-TPS-8114	
EPDM	-	USA SRBE COQ A-TPS-8118	
3-6077 RTV	-	USA SRBE COQ A-TPS-8113	
RTV-133	-	USA SRBE COQ A-TPS-8102	
Zinc Primers	-	USA SRBE COQ A-TPS-8129	
SNS 300AR	-	USA SRBE COQ A-TPS-8124	CN 042
K5NA	-	USA SRBE COQ A-TPS-8108	
RT 455	-	USA SRBE COQ A-TPS-8130	CN 042

The Strut Closeout Covers insulation requirements are specified on USA SRBE drawings 10755-0049 through 10755-0054 (Cover Plate, Insulated and Cover Assembly, Insulated). Installation and closeout of the Insulated Cover Assemblies are specified on USA SRBE drawings 10111-0027, 10112-0024 (Attach Ring Installation, Aft Booster Assy.), 10100-0054 (SRB ET Attach Ring Cover Installation) and 10100-0059 (SRB TPS Closeout Installation).

Other documents controlling Attach Ring/Strut Closeout insulation requirements include:

EPDM Rubber Insulation:

10753-0002	Thermal Insulation, EPDM-Neoprene Rubber, Silica Filled
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10PRC-0348 Procedure for Insulation, EPDM, Bonding and Fabrication on Steel Surfaces

Substrate Protective Finish:

10PRC-0442 Phosphate Coating, Heavy, Manganese or Zinc Base

PR-855:

10753-0011 Sealant, Foam
10PRC-0026 Procedure for PR-855, Application

RTV 3-6077:

10753-0012 Ablative, RTV Silicone
10PRC-0426 Procedure for RTV 3-6077

K5NA/RT 455 (ALT.):

MSFC-SPEC-1918 Ablative Compound, Thermal
MSFC-SPEC-1919 Ablative Compound, Thermal, Application and Cure of

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SNS 300AR Tape:

10753-0050 Thermal Tape SNS 300AR

RTV-133:

10753-0014 Adhesive, RTV
10PRC-0025 Procedure For RTV-133, Application

O Remove all TPS after every flight

B. TESTING

O Verification of EPDM constituents, formulation, mix and cure is accomplished by performing specific gravity, tensile strength, elongation, hardness, ash content and thermal conductivity tests. Test values are reported as the average of at least three test specimens from each lot of

rubber. Material property and test requirements are specified in USA SRBE-BPC drawing 10753-0002. (Degraded Properties)

- O K5NA/RT 455 (ALT.) acceptability is verified per OMRSD File V, Vol. I, requirement no. B09GEN.010, 10REQ-0021 para. 4.1.3 and MSFC-SPEC-1918/MSFC-SPEC-1919.

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- o To verify acceptability of K5NA/RT 455 (ALT.) constituents, formulation, mixing, application and cure for each lot of K5NA/RT 455 (ALT.) submitted for acceptance, vendor performs tests such as tensile, hardness, specific gravity and thermogravimetric analysis (TGA). (Degraded Properties)

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- o To verify acceptability of K5NA/RT 455 (ALT.) constituents, formulation, mixing application and cure for production hardware, three tensile specimens are prepared and tested from at least one batch mixed, for each day of K5NA/RT 455 (ALT.) processing. Hardness is verified for each batch and on the hardware. (Degraded Properties).

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- O EPDM, K5NA/RT 455 (ALT.) and RTV-133 thickness requirement are verified by inspection, in accordance with drawing 10100-0001. (Inadequate Thickness) Thickness/configuration of RTV 3-6077 and PR-855 foam are verified by inspection, in accordance with drawing 10100-0061. (Improper Installation)

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- O Verification of manufacturing operations (substrate preparation, vulcanization process, etc.) to verify proper bonding of rubber to substrate is accomplished by performing a peel test on a specimen prepared and concurrently cured with each component. Hardness readings are taken on at least 10 places on the completed component in accordance with 10PRC-0348.

C. INSPECTION

Inspections to verify the processing and manufacturing of the EPDM insulated components are accomplished by USA SRBE QAR. (Degraded Properties)

Inspections to verify the processing and application of insulation materials are accomplished by SPC. (Degraded Properties)

- O USA SRBE QAR certifies that the formulation, properties and manufacture of the EPDM material conforms to 10753-0002. USA SRBE QAR verifies requirements in accordance with USA SRBE SIP 1453. (Degraded Properties)
- O USA SRBE-QAR verifies results of hardness and peel tests in accordance with SIP 1453. (Debonding)
- O USA SRBE QAR verifies that EPDM thickness is within drawing tolerance in accordance with USA SRBE SIP 1453. (Inadequate Thickness)
- O USA SRBE QAR verifies substrate phosphate coating, substrate preparation and bonding/vulcanization in accordance with 10PRC-0348 and SIP 1453. USA SRBE QAR verifies peel test data in accordance with SIP 1453 which verifies bonding of flight components. (Debonding)
- O K5NA/RT 455 (ALT.) acceptability is verified per 10REQ-0021, para. 4.1.3, including the following:
 - o Preparation of surfaces to be insulated: verify that the surface is abraded, clean and dry before insulation application is made. (Debonding)

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- o Verification of the formulation of each lot of K5NA/RT 455 (ALT.) insulation received. (Degraded Properties) CN 042
- o Application of K5NA/RT 455 (ALT.): verify that K5NA/RT 455 (ALT.) is applied within the application life. (Degraded Properties) CN 042
- o Completion of cure: verify hardness meets Durometer type D 15 minimum. (Degraded Properties)
- o Thickness and integrity of application: verify K5NA/RT 455 (ALT.) applications for compliance with drawing requirements or that the K5NA/RT 455 (ALT.) thickness is equal to adjacent insulation thickness and has a smooth surface finish. (Inadequate Thickness) CN 042
- O Shelf life, formulation, mixing, surface preparation, application, cure, and physical properties of K5NA/RT 455 (ALT.), PR-855, RTV-133 and RTV 3-6077 are verified per OMRSD File V, Vol. 1, requirement number B09GEN.010. (Degraded Properties) CN 042
- O Perform TPS assessment walkdown inspection prior to rollout per OMRSD File V, Vol. 1, requirement number B09TP0.010.
 - o Visually assess the TPS to identify possible degradation or damage. (Degraded Properties)
- O Visual inspection verifies the integrity of TPS and/or TPS topcoat on the SRB/ET attach ring/attach struts prior to rollout per OMRSD File V, Vol. 1, requirement number B09TP0.010. (Degraded Properties/Debonding)
- O TPS closeout application inspection is performed after completion of K5NA/RT 455 (ALT.) cure on the SRB/ET attach ring/attach struts per OMRSD File V, Vol. 1, requirement number B09TP0.020. (Degraded Properties) CN 042
- O SPC Quality performs closeout and insulated cover inspections prior to the installation of insulated covers and verifies torquing of fasteners, in accordance with drawing 10100-0061. (All Failures)
- O Inspect install insulating tape per OMRSD File V, Vol. I Requirement No. B09CB0.010 (Inadequate TPS thickness)

Critical Processes/Inspections:

- O Substrate protective finish per 10PRC-0442
- O EDPM Rubber formulation, bonding and fabrication per 10753-0002 and 10PRC-0348
- O PR-855 Silicone foam application per 10PRC-0026
- O 3-6077 RTV Application per 10PRC-0426
- O AF-40 or SNS 300AR tape installation per 10130-0001 thru -0005, 10111-0038, 10112-0038
- O K5NA/RT 455 (ALT.) application per MSFC-SPEC-1919
- O RTV-133 application per 10PRC-0025 CN 042

D FAILURE HISTORY

- O Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- O Not applicable to this failure mode